

# **4.5-V to 18-V Input Voltage, 3-A/2-A/2-A Output Current Triple Synchronous Step-Down Converters Evaluation Module**

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This document presents the information required to operate the TPS65261/TPS65261-1 PMIC as well as the support documentation including schematic, layout, hardware setup and bill of materials.

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## 1 Background

The TPS65261/TPS65261-1 PMIC is a triple 3-A/2-A/2-A output current, synchronous step-down (buck) converter with an operational range of 4.5 V to 18 V. The TPS65261/TPS65261-1 features an automatic power sequence with connecting MODE pin to V7V and configuring EN1/2/3 pins. The device also features an open drain RESET signal to monitor power down. The TPS65261 operates in pulse skipping mode (PSM) and the TPS65261-1 operates in force continuous current mode (FCC) at light load.

As there are many possible options to set the converters, [Table 1](#) presents the performance specification summary for the EVM.

**Table 1. Summary of Performance**

Test Conditions	Performance
VIN = 4.5 V to 18 V f <sub>SW</sub> = 600 kHz (25°C ambient)	BUCK1, 1.2 V, up to 3 A BUCK2, 3.3 V, up to 2 A BUCK3, 1.8 V, up to 2 A RESET, pull low when VDIV lower than 1.23 V

This evaluation module is designed to provide access to the features of the TPS65261/TPS65261-1. Some modifications can be made to this module to test performance at different input and output voltages, current and frequency operation. Contact TI Field Applications Group for advice on these matters.

## 2 Board Layout

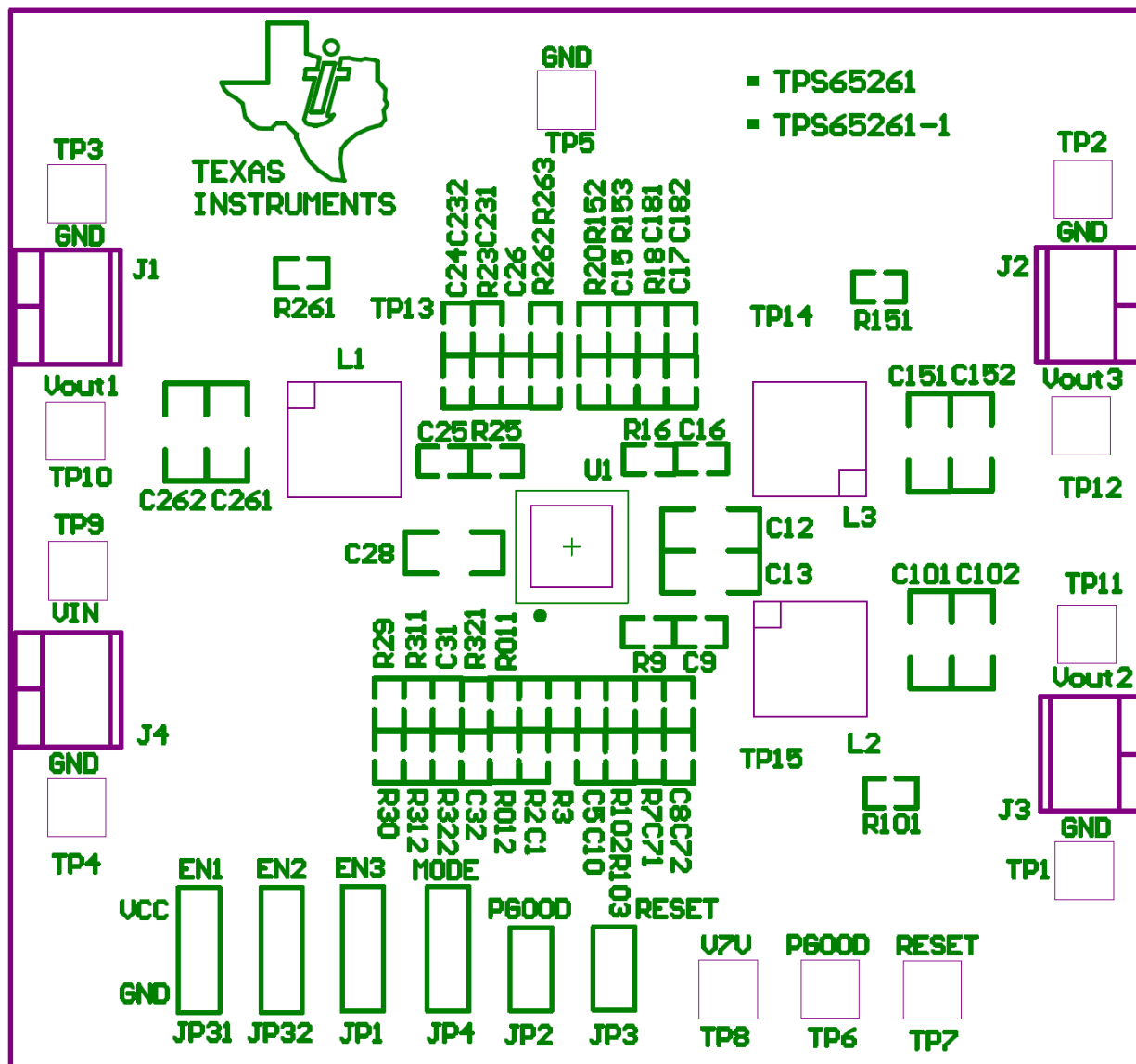


Figure 1. Placement

## 2.1 EVM Layout

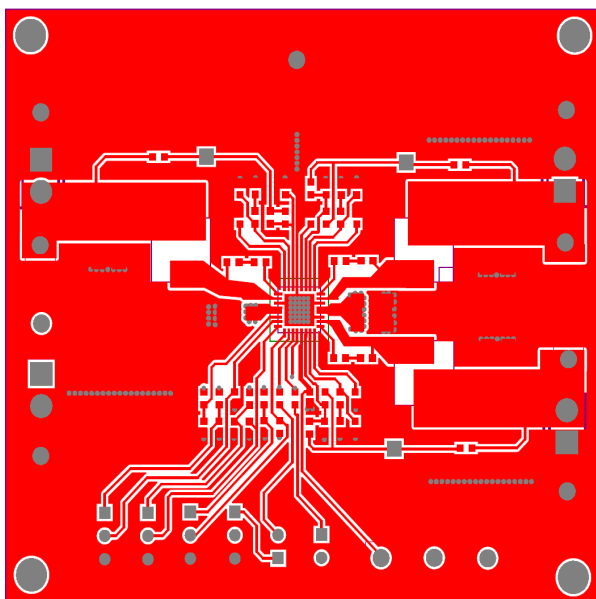


Figure 2. Board Layout (Top Layer)

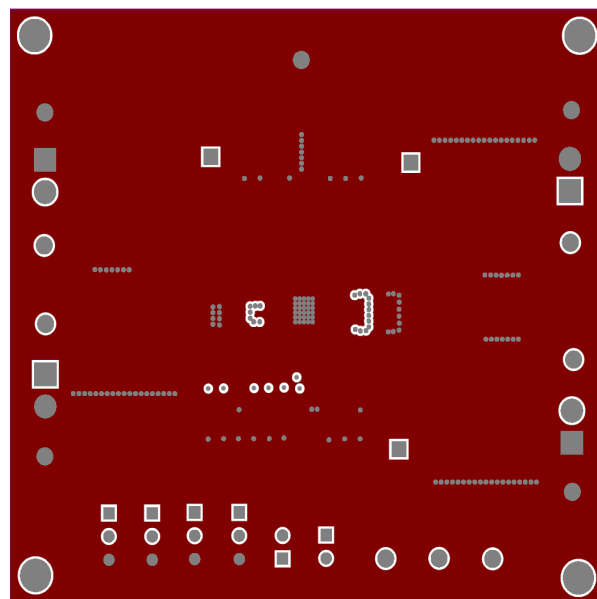


Figure 3. Board Layout (Second Layer)

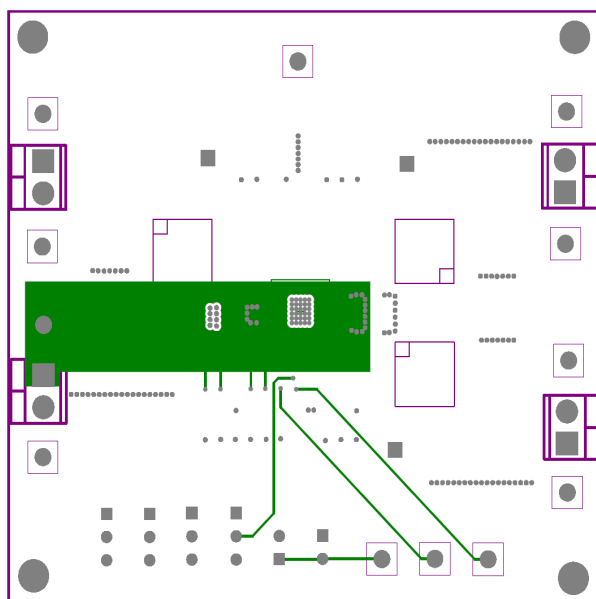


Figure 4. Board Layout (Third Layer)

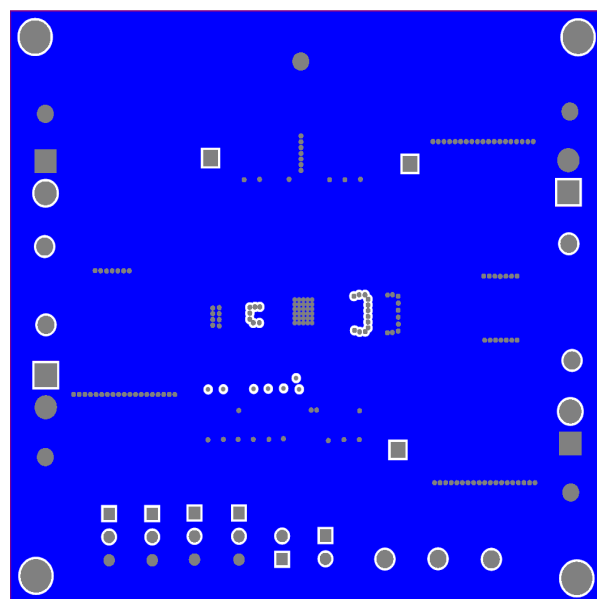
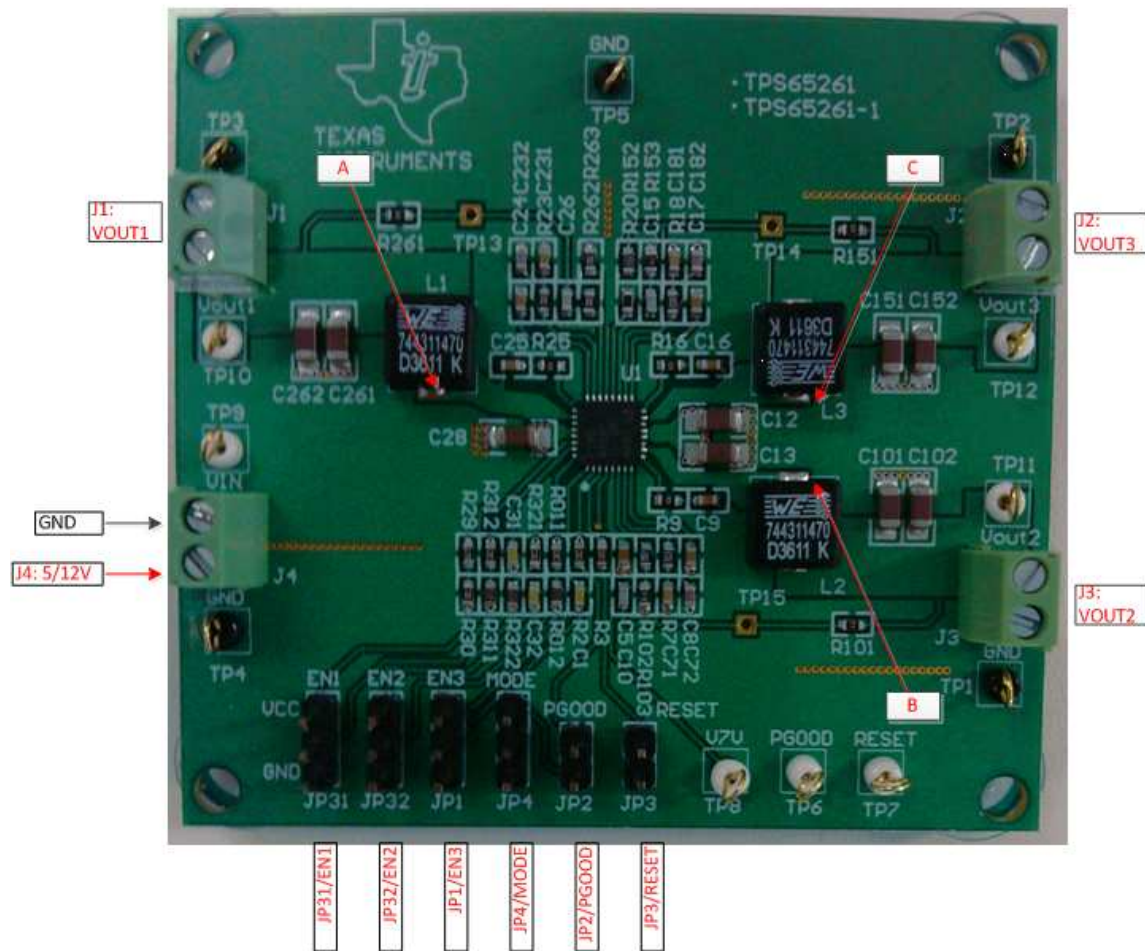


Figure 5. Board Layout (Bottom Layer)

### 3 Bench Test Setup Conditions



### 3.1 Jumpers and Switches

Number	Function	Placement	Comment
JP1	BUCK3 enable (EN3)	Connect EN3 to GND to disable VOUT3, connect EN3 to VIN through a 100-k $\Omega$ resistor to enable VOUT3; Leave open to enable VOUT3.	
JP2	PGOOD pull-up	PGOOD pull-up resistor connected to the V7V; Leave the two pins un-connected set the pull-up voltage open; short the two pins set the pull-up voltage to be V7V.	On board V7V is 6.3 V when VIN is 12 V
JP3	RESET pull-up	RESET pull-up resistor connected to the V7V; Leave the two pins un-connected set the pull-up voltage open; short the two pins set the pull-up voltage to be V7V.	On board V7V is 6.3 V when VIN is 12 V
JP4	Mode	Power sequencing mode control pin. Connect this pin to GND to set power sequence with dedicated enable pin; Connect this pin to V7V set the power sequence with the pre-defined power up and power down sequence.	
JP31	BUCK1 enable (EN1)	Connect EN1 to GND to disable VOUT1, connect EN1 to VIN through a 100-k $\Omega$ resistor to enable VOUT1; Leave open to enable VOUT1.	
JP32	BUCK2 enable (EN2)	Connect EN2 to GND to disable VOUT2, connect EN2 to VIN through a 100-k $\Omega$ resistor to enable VOUT2; Leave open to enable VOUT2.	

## 4 Power-Up Procedure

Power sequence with dedicated enable pin:

1. Connect JP4 to GND.
2. Apply 4.5 V - 18 V to J4.
3. Toggle JP31, JP32 or JP1 to enable VOUT1, VOUT2 and VOUT3 respectively.
4. Apply loads to the output connectors.

Power sequence with the pre-defined power up and power down sequence:

1. Connect JP4 to V7V.
2. Connect JP31 to High (or Low), JP32 to High (or Low)
3. Apply 4.5 V - 18 V to J4.
4. Toggle JP1 to enable VOUT1, VOUT2 and VOUT3.
5. Apply loads to the output connectors.

## 5 Schematic

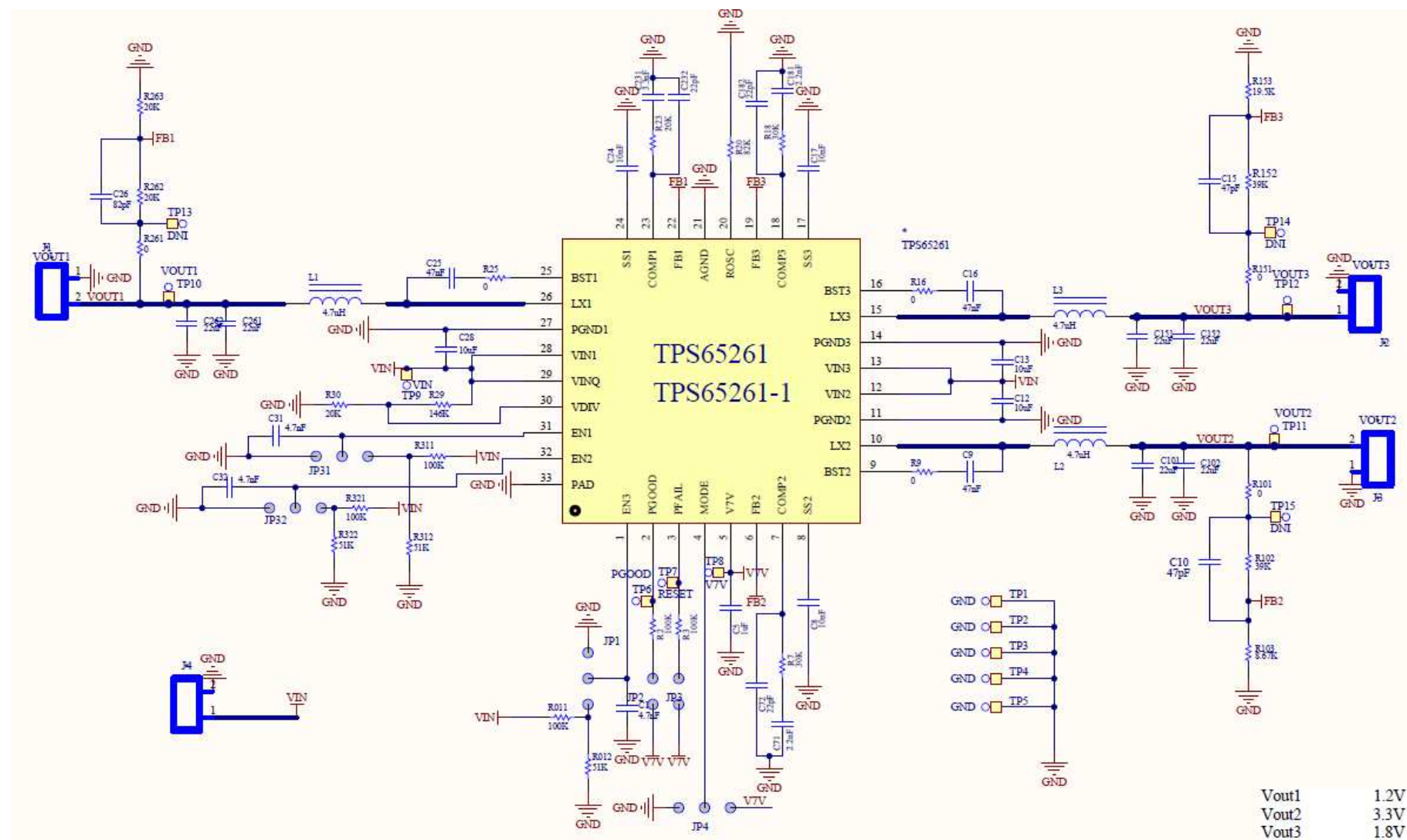


Figure 7. TPS65261/TPS65261-1 Schematic

## 6 Bill of Materials

No.	Designator	Value	Quantity	Footprint	Manufacturer	Part Number	Description
1	C1, C31, C32	4.7nF	3	0603	Generic		CAP 4.7nF 50V CERAMIC X7R 0603
2	C9, C16, C25	47nF	3	0603	Generic		CAP 47nF 50V CERAMIC X7R 0603
3	C231	3.3nF	1	0603	Generic		CAP 3.3nF 50V CERAMIC X7R 0603
4	C71, C181	2.2nF	2	0603	Generic		CAP 2.2nF 50V CERAMIC X7R 0603
5	C101, C102, C151, C152, C161, C162	22uF	6	1206	Generic		CAP 22uF 16V CERAMIC X5R 1206
6	C72, C182, C232	22pF	3	0603	Generic		CAP 22pF 50V CERAMIC X7R 0603
7	C10, C15	47pF	2	0603	Generic		CAP 47pF 50V CERAMIC X7R 0603
8	C12, C13, C28	10uF	3	1206	Generic		CAP 10uF 25V CERAMIC X5R 0603
9	C26	82pF	1	0603	Generic		CAP 82pF 50V CERAMIC X7R 0603
10	C8, C17, C24	10nF	3	0603	Generic		CAP 10nF 50V CERAMIC X7R 0603
11	C5	1uF	1	0603	Generic		CAP 1uF 50V CERAMIC X5R 0603
12	R011, R312, R322	51K	3	0603	Generic		RES 51k OHM 1/10W 1% 0603 SMD
13	R011, R2, R3, R311, R321	100K	5	0603	Generic		RES 100k OHM 1/10W 1% 0603 SMD
14	R29	146K	1	0603	Generic		RES 146k OHM 1/10W 1% 0603 SMD
15	R23, R30, R262, R263	20K	4	0603	Generic		RES 20k OHM 1/10W 1% 0603 SMD
16	R7, R18	30K	2	0603	Generic		RES 30k OHM 1/10W 1% 0603 SMD
17	R20	73.2K	1	0603	Generic		RES 73.2k OHM 1/10W 1% 0603 SMD
18	R9, R16, R25, R101, R151, R261	0	6	0603	Generic		RES 0 OHM 1/10W 1% 0603 SMD
19	R102, R152	39K	2	0603	Generic		RES 39k OHM 1/10W 1% 0603 SMD
20	R153	19.5K	1	0603	Generic		RES 19.5k OHM 1/10W 1% 0603 SMD
21	R103	8.67K	1	0603	Generic		RES 8.67k OHM 1/10W 1% 0603 SMD
22	L1, L2, L3	4.7uH	3	IND_744311470	Würth Electronics Inc	744311470	SMT power inductor
23 <sup>(1)</sup>	JP1, JP4, JP31, JP32	HEADER 3 PIN	4	JMP0.3	Mil-Max	800-10-064-10-001000	Three Pin Header, Break SIPs into groups of 3
24 <sup>(2)</sup>	JP2, JP3	HEADER 2 PIN	2	JMP0.2	Mil-Max	800-10-064-10-001000	Two Pin Header, Break SIPs into groups of 2
25	J1, J2, J3, J4	ED500/2DS	4	TB_2X5.0MM	OnShore Technology Inc	ED500/2DS	Terminal Block, 2-pin, 15-A, 5.0mm
26	TP6, TP7, TP8, TP9, TP10, TP11, TP12	Test Point White	7	TP	Keystone	5002	TEST POINT PC MINI .040"D WHITE
27	TP1, TP2, TP3, TP4, TP5	Test Point Black	5	TP	Keystone	5001	TEST POINT PC MINI .040"D BLACK
28	TP13, TP14, TP15	Test Point White	DNI	TP	Keystone	5002	TEST POINT PC MINI .040"D WHITE
29			6				Jumper, 2.54mm, open top, Applied on item 23, 24
30 <sup>(3)</sup>			4		3M	SJ-5303 (CLEAR)	BUMPON HEMISPHERE .44X.20 CLEAR

<sup>(1)</sup> Item 23: split into 3 pins.

<sup>(2)</sup> Item 24: split into 2 pins.

<sup>(3)</sup> Install item 25 on bottom at corners.

No.	Designator	Value	Quantity	Footprint	Manufacturer	Part Number	Description
31 <sup>(4)</sup>	U1		1	RHB	Texas Instruments	TPS65261RHBR	
32 <sup>(4)</sup>	U1		1	RHB	Texas Instruments	TPS65261-1RHBR	

<sup>(4)</sup> Select item 31 (TPS65261RHBR) or item 32 (TPS65261-1RHBR) according to product target.

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*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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#### Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

### **FCC Interference Statement for Class B EVM devices**

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

### **Concerning EVMs including detachable antennas**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **Concernant les EVMs avec appareils radio**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### **Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
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